

PATENT ABSTRACTS OF JAPAN

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(54) HIGH FLOWABILITY CONCRETE COMPOSITION

(57)Abstract:

PURPOSE: To improve flowability by mixing a hydraulic material, water, a fine aggregate, a coarse aggregate and a cement dispersing agent consisting of an alkenyl ether/maleic anhydride copolymer expressed by a specific formula in a prescribed weight ratio.

CONSTITUTION: The cement dispersing agent is obtained by mixing the alkenyl ether/maleic anhydride copolymers, the hydrolyzed materials or the salt expressed by formula (a), $R1O(AO)mR2$, and formula (b), $R1O(AO)nR2$ (AO represents a 2-18C oxyalkylene, R1 represents a 2-5C alkenyl, R2 represents a 1-4C alkyl and each of (m) and (n) represents average addition numbers of oxyalkylene respectively of 1-40 and 100-150) in a weight ratio of component (a)/component (b) = (97-59)/(3-50). Next, a high flowable concrete composition consisting of 350-700 kg hydraulic material as a unit weight in 1 m³ concrete, ≤180 kg water as a unit weight in 1 m³ concrete, an adequate quantity of the fine aggregate and the coarse aggregate and 0.05-3 pts.wt. cement dispersing agent per 100 pts.wt. hydraulic material is obtained by kneading the dispersing agent with the cement materials.

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CLAIMS

[Claim(s)]

[Claim 1] A hydraulic component material whose unit weight in concrete of ingredient A-E: (A) $1\text{--}m^3$ of the following is 350-700 kg;

(B) Water whose unit quantity of water in concrete of $1m^3$ is 185 kg or less;

(C) A fine aggregate;

(D) Coarse aggregate;

(E) Following general formula (I) as a (a) ingredient

$R_1O(AO)_m R_2 \dots (I)$

[however AO(s) are one sort or two sorts or more of mixtures of an oxyalkylene group of the carbon numbers 2-18; it may add to block like shape at the time of two or more sorts, or it may be added in the shape of random. An alkenyl group of the carbon numbers 2-5 and R_2 of R_1 are an alkyl group of the carbon numbers 1-4, and a copolymer of alkenyl ether and a maleic anhydride m is indicated to be with the number of average addition mols of an oxyalkylene group by] which is 1-40. Following general formula (II) as one sort or two sorts or more, and the (b) ingredient of a copolymer in which the mole ratio is 30-70:70-30, its hydrolyzate, or a salt of the hydrolyzate

$R_1O(AO)_n R_2 \dots (II)$

[however AO(s) are one sort or two sorts or more of mixtures of an oxyalkylene group of the carbon numbers 2-18; it may add to block like shape at the time of two or more sorts, or it may be added in the shape of random. An alkenyl group of the carbon numbers 2-5 and R_2 of R_1 are an alkyl group of the carbon numbers 1-4, and a copolymer of alkenyl ether and a maleic anhydride n is indicated to be with the number of average addition mols of an oxyalkylene group by] which is 100-150. The mole ratio contains one sort of a salt of a copolymer which is 30-70:70-30, its hydrolyzate, or its decomposition product, or two sorts or more. A high fluidity concrete constituent which weight ratios of the aforementioned (a) ingredient and the aforementioned (b) ingredient are 97-50:3-50, and is characterized by the amount used comprising cement dispersing agent, which is 0.05 - 3 weight section to the hydraulic component material 100 above-mentioned weight section.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the high fluidity concrete constituent which it excels in the mobility which adds a cement dispersing agent to this, using a hydraulic component material as a binding material, and the temporal fall is small, and has still less segregation.

[0002]

[Description of the Prior Art] Even if the conventional concrete kneads homogeneously enough by a mixer etc., carry, and drive it in, it tends to cause segregation in the process of tamping, and its mobility is not enough, but therefore, Or concrete does not spread round the reentrant angle part of a complicated-shaped concrete member, a member with high iron rod density, or a concrete member, it has the evil in which workability is further worsened for a temporal fluid fall (it is called slump loss below).

[0003] In order to be durability-like and to make reliable concrete from the art by the present moreover, the careful construction by the skilled craftsman in the spot is required, and tamping work while paying careful attention especially is indispensable.

[0004] Generally, in order to improve the workability of concrete, the method of using admixture, such as use of plasticizers, such as a high-range water reducing agent or a high-performance AE water-reducing agent, silica form with a fine particle size, or ground granulated blast-furnace slag, is tried, but. Since it is inferior to mobility only by saying [that concrete is only soft (a slump is large)] and is moreover accompanied by temporal slump loss, by the conventional method, good restoration nature is hard to be obtained.

[0005]

[Problem(s) to be Solved by the Invention] Now, trends, such as shortage of rapid increase of the amount of construction enterprises, an architect engineer, and a construction worker, an increase in the construction work under particular status environment, or highly-efficient-izing of a structure, are seen. In such change, reservation of the formation of ** people, modernization of an construction work, rapid construction, highly-efficient-izing, and reliability, etc. are raised as art required of future concrete.

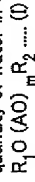
[0006] In order to solve this problem, it excels in mobility, and that temporal fall is small, and it craves for little development of high fluidity concrete of segregation further. This concrete is a material which it not only can attain ** people-ization at the time of placing, but makes it possible to promote greatly the modernization of concrete works, such as dissolution of noise, and reform of a construction system, accompanying tamping work.

[0007]

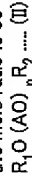
[The means and operation for solving a problem] As a result of inquiring wholeheartedly that this invention persons should solve the above problem, the unit quantity of water of per 1 m^3 is [the unit weight of 185 kg or less and a hydraulic component material] 350-700 kg. The concrete composition obtained by adding the specific cement dispersing agent which is furthermore in this is excellent in mobility, and it finds out having the characteristic that the temporal fall is small and still less segregation is, and came to complete this invention.

[0008] Namely, hydraulic component material whose unit weight in concrete of following ingredient A-E(A) $1\text{--}1 \text{ m}^3$ of this invention is 350-700 kg.

(B) Following general formula (I) as water (C) fine aggregate (D) coarse aggregate (E) whose unit quantity of water in concrete of 1 m^3 is 185 kg or less, and a (a) ingredient



[however AO(s) are one sort or two sorts or more of mixtures of an oxyalkylene group of the carbon numbers 2-18, It may add to block like shape at the time of two or more sorts, or it may be added in the shape of random, An alkenyl group of the carbon numbers 2-5 and R_2 of R_1 are an alkyl group of the carbon numbers 1-4, and a copolymer of alkenyl ether and a maleic anhydride m is indicated to be with the number of average addition mols of an oxyalkylene group by] which is 1-40. Following general formula (II) as one sort or two sorts or more, and the (b) ingredient of a copolymer in which the mole ratio is 30-70:70-30, its hydrolyzate, or a salt of the hydrolyzate



[however AO(s) are one sort or two sorts or more of mixtures of an oxyalkylene group of the carbon numbers 2-18, It may add to block like shape at the time of two or more sorts, or it may be added in the shape of random, An alkenyl group of the carbon numbers 2-5 and R_2 of R_1 are an alkyl group of the carbon numbers 1-4, and a copolymer of alkenyl ether and a maleic anhydride n is indicated to be with the number of average addition mols of an oxyalkylene group by] which is 100-150. The mole ratio contains one sort of a salt of a copolymer which is 30-70:70-30, its hydrolyzate, or its decomposition product, or two sorts or more, Weight ratios of the aforementioned (a) ingredient and the aforementioned (b) ingredient are 97-50:3-50, and the amount used is related with a high fluidity concrete constituent comprising cement dispersing agent; which is 0.05 ~ 3 weight section to the hydraulic component material 100 above-mentioned weight section.

[0009] This invention is explained in detail below.

[0010] Portland cement can be mentioned as an example of representation of a hydraulic component material used in this invention. In order to improve mobility and segregation resistance of concrete, it is preferred to use a mixture of one sort or two sorts or more of pulverized coal chosen from blast furnace slag powder, fly ash, silica stone powder, natural mineral powder, and silica **** particle powder and portland cement.

[0011] The amount of one sort or two sorts or more of pulverized coal used chosen from blast furnace slag powder, fly ash, silica stone powder, natural mineral powder, and silica **** particle powder, Although not limited in particular, when the manifestation nature of early age strength, etc. are taken into consideration, substitution which makes 50 % of the weight a maximum to portland cement is preferred, and 5 to 40% of the weight of substitution is still more preferred.

[0012] As for fineness of said hydraulic component material, it is preferred that it is 2,500-

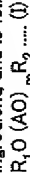
200,000 cm^2/g in a plain value. Fineness below by 2,500 cm^2/g . Segregation of concrete and

depressor effect of bleeding water are low, and in being more than 200,000 cm^2/g , practicality is missing for reasons of increase of unit quantity of water, increase of the amount of cement dispersing agent used, or increase of cost of pulverized coal manufacture.

[0013] Although said 350-700 kg of hydraulic component materials are contained in concrete of 1 m^3

and it is conditions that the amount of kneading water is 185 kg or less in 1 m^3 . Use of a cement dispersing agent shown in this invention enables it to secure high mobility, high slump holdout, and low segregation resistance. Mobility, slump holdout, and segregation resistance can be further raised by using together a cement dispersing agent and the above-mentioned pulverized coal which are shown in this invention.

[0014] A cement dispersing agent used in this invention comprises the (a) ingredient and the (b) ingredient, and is following general formula (I) as a (a) ingredient.



[however AO(s) are one sort or two sorts or more of mixtures of an oxyalkylene group of the carbon numbers 2-18, It may add to block like shape at the time of two or more sorts, or it may be added in the shape of random, and, as for R_1 , an alkyl group of the carbon numbers 1-4 and m of an alkenyl group of the carbon numbers 2-5 and R_2 are 1-40 in the number of average addition mols of an oxyalkylene group. Following general formula (II) as one sort or two sorts or more, and the (b) ingredient of a copolymer in which the mole ratio is 30-70:70-30 in a copolymer of alkenyl ether and

a maleic anhydride which are shown by], its hydrolyzate, or a salt of the hydrolyzate

$R_1O(AO)_n$ (II)

[However $AO(s)$ are one sort or two sorts or more of mixtures of an oxalkylene group of the carbon numbers 2-18. It may add to block like shape at the time of two or more sorts, or it may be added in the shape of random, and, as for R_1 , an alkyl group of the carbon numbers 1-4 and n of an alkyl group of the carbon numbers 2-5 and R_2 are 100-150 in the number of average addition mols of an oxalkylene group. With a copolymer of alkyl ether and a maleic anhydride which are shown by]. The mole ratio contains one sort of a copolymer which is 30-70:70-30, its hydrolyzate, or a salt of the hydrolyzate, or two sorts or more, Wt. ratios of the aforementioned (a) ingredient and the aforementioned (b) ingredient are 97-50:3-50, and the amount used is characterized by being 0.05 - 3 weight section to hydraulic component material 100 weight section.

[0015]As an alkyl group of the carbon numbers 2-5 shown by R_1 in said general formula (I) and said general formula (II), although there are a vinyl group, an allyl group, a metalyl group, an 1,4-dimethyl-2-propenyl group, 3-methyl-3 butenyl group, etc., a general-purpose allyl group is preferred.

[0016]As an oxalkylene group of the carbon numbers 2-18 shown by AO , although there are an oxyethylene group, an oxypropylene group, a oxy butylene group, a oxytetramethylen group, an oxide decylene group, a oxytetradecylene group, a oxyhexadecylene group, a oxyoctadecylene group, etc., Especially an oxalkylene group of the carbon numbers 2-4 is preferred.

[0017]As an alkyl group of the carbon numbers 1-4 shown by R_2 , there are a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, an isobutyl group, a tertiary butyl group, etc. Since an air content taken into concrete increases when a carbon number is five or more, when calculating the amount of low-altitude mind, it is good to choose an alkyl group of the carbon numbers 1-4.

[0018]A several meters average addition mol of an oxalkylene group the aforementioned (a) ingredient which are 1-40. When it is used alone, a naphthalene sulfonic acidformaldehyde quantity condensate system cement dispersing agent, it becomes a cement dispersing agent of conventional types, such as a sulfonation melamine resin system cement dispersing agent, a ligninsulfonic acid system cement dispersing agent, and a polycarboxylic acid system cement dispersing agent, and a cement dispersing agent in which almost equivalent character is shown.

[0019]However, although the aforementioned (b) ingredient whose average addition mol n [several] of an oxalkylene group is 100 or more serves to improve the mobility of concrete in itself, in addition to this, it increases mobility temporally, and has work with it which suppresses generating of brezing further. The effect is so remarkable that a value of size of n is especially easy to come. Especially if a value of n in the aforementioned (b) ingredient with this character is 100 or more, it will not be limited, but 100-150 are preferred, judging from the ease of manufacture, and balance of performance.

[0020]Therefore, there is a danger of causing segregation in fluid increase temporal an independent target or when it is used in superfluous with the aforementioned (b) ingredient. Therefore, as for the aforementioned (b) ingredient, it is preferred to use it combining other cement dispersing agents.

[0021]In this case, causing-increase in addition of cement dispersing agent for obtaining predetermined mobility *** when concrete is produced for the aforementioned (b) ingredient combining a naphthalene sulfonic acid system cement dispersing agent or a melamine sulfonic acid system cement dispersing agent. However, when it is used combining the aforementioned (a) ingredient and the aforementioned (b) ingredient, it does not have bad influence on the mobility of concrete at all.

[0022]That is, it makes it possible to make concrete excellent in mobility and slump holdout by using a cement dispersing agent which combined the aforementioned (a) ingredient and the aforementioned (b) ingredient with sufficient balance. This concrete shows a tendency segregation and whose bleeding water decrease to a still more surprising thing. So, if a cement dispersing agent of this invention is used, it will also be the feature not to necessarily need a water soluble polymer needed in order to control separation resistance nature or brezing, as shown in JP 3-237049A, etc. in a concrete composition of this invention.

[0023]Although the mixture ratio of the aforementioned (a) ingredient of a cement dispersing agent and the aforementioned (b) ingredient used in this invention changes with numbers of average

addition mols of an oxalkylene group in a copolymer to be used, it is preferred to use it by the range of 97-50:3-50.

[0024]This cement dispersing agent shown in this invention is possible also for concomitant use with other publicly known cement admixture, for example, an air entraining agent, a waterproof agent, an intensity improver, a hardening accelerator, etc., and a defoaming agent can also be further added and used for it if needed.

[0025]A copolymer shown in the aforementioned (a) ingredient and the aforementioned (b) ingredient can be easily obtained by carrying out copolymerization of a compound and a maleic anhydride of general formula (I) or general formula (II) using a peroxide catalyst. Although the mole ratio is chosen from 30-70:70-30, it is 50:50 preferably. In that case, it may mix also with other copolymerizable ingredients, such as styrene, alpha olefin, and vinyl acetate, and many to 30 % of the weight to this copolymer, and copolymerization may be carried out. Either an anhydride hydrolyzate or its salt can be used for a copolymer.

[0026]A maleic anhydride unit which carried out copolymerization hydrolyzes, and hydrolyzate of this copolymer serves as a maleic acid unit.

[0027]The maleic acid unit forms a salt and a salt of hydrolyzate of this copolymer has ammonium salt, organic amine salt besides alkali metal salt, such as lithium salt, sodium salt, potassium salt, magnesium salt, and calcium salt, and alkaline earth metal salt, etc.

[0028]The amount of this cement dispersing agent used in this invention adds 0.1 to 1 weight section preferably 0.05 to 3 weight section to hydraulic component material 100 weight section. A stage of addition of these various cement dispersing agents can be chosen arbitrarily, and even if it uses it, mixing kneading water, it makes possible any methods, such as the method of carrying out adding after mixing into already scoured concrete.

[0029]

[Effect of the Invention]The high fluidity concretes shown in this invention are high mobility and high segregation resistance, and have the performance by which the slump holdout accompanying temporality has moreover been improved substantially.

[0030]Therefore, the high fluidity concrete constituent by this invention, For example, lining of a common civil engineering and construction structure and a tunnel, a mass concrete, it can use for wide range uses, such as placing of the concrete to a narrow gap or a complicated mold, and construction to a concrete structure thing with high iron rod density, by backfilling, such as a sewer, prestressed concrete, precast concrete, etc.

[0031]Hereafter, although the high fluidity concrete constituent by this invention is explained in detail with an example, this invention is not limited to this.

[0032]

[Examples 1-16] Based on the preparation shown in Table 1, the cement dispersing agent which consists of a copolymer shown in a 40-1 concrete material and table-2 is thrown in using a 50-L pan mixer, it performed kneading for 3 minutes and the high fluidity concrete which are 21-25 cm of target slumps, a target slump flow value of 40-60 cm, and 2% or less of target air volume was adjusted. After scouring, discharging to the mixing vessel after going up and performing scour return of the predetermined number of times, aging of the slump to the 60-minute backward, a slump flow, and flow speed was measured. A slump, an air content, setting time, the measuring method of compressive strength, and the manufacturing method of the testing sample for compressive strength were altogether performed based on Japanese Industrial Standard (JIS-A6204).

[0033]Measurement of a slump, a slump flow, and flow speed performed evaluation of the mobility of concrete, and also it was considered as the index of the segregation resistance judgment by performing observation by viewing of the state of the concrete at that time. When O was checked as the distinction when not having dissociated thoroughly, it was expected that it has not dissociated mostly and separation of O and material was checked a little, it was considered as **, and when separation was accepted clearly, it was considered as x. The result is shown in table-3.

[0034]

[Comparative examples 1-6] The same operation as Examples 1-16 was performed, and the concrete for comparison was adjusted.

[0035]The result is shown in table-3.

[0036]

表-1

| 区分 | 配合 (kg/m ³) | | | セメント分材料の添加量 | |
|--------|-------------------------|-----|-----|---------------|--------------------------------|
| | 水硬性成分材料 | | | (対 水硬性成分材料率%) | |
| | C | SL | FA | S/SC | Y |
| 実施例 1 | 245 | 105 | 0 | 0 185 | 49.0 共重合体(b)/共重合体(e) 0.13/0.07 |
| 実施例 2 | 245 | 105 | 0 | 0 175 | 49.0 共重合体(b)/共重合体(e) 0.17/0.05 |
| 実施例 3 | 350 | 150 | 0 | 0 175 | 47.0 共重合体(a)/共重合体(e) 0.14/0.09 |
| 実施例 4 | 350 | 150 | 0 | 0 175 | 47.0 共重合体(b)/共重合体(e) 0.17/0.04 |
| 実施例 5 | 350 | 150 | 0 | 0 175 | 47.0 共重合体(c)/共重合体(e) 0.12/0.12 |
| 実施例 6 | 350 | 150 | 0 | 0 175 | 47.0 共重合体(d)/共重合体(e) 0.15/0.10 |
| 実施例 7 | 455 | 195 | 0 | 0 165 | 45.5 共重合体(b)/共重合体(e) 0.15/0.02 |
| 実施例 8 | 280 | 0 | 70 | 0 175 | 49.0 共重合体(b)/共重合体(e) 0.16/0.05 |
| 実施例 9 | 400 | 0 | 100 | 0 175 | 47.0 共重合体(b)/共重合体(e) 0.15/0.04 |
| 実施例 10 | 520 | 0 | 130 | 0 165 | 45.5 共重合体(b)/共重合体(e) 0.15/0.02 |
| 実施例 11 | 315 | 0 | 35 | 175 | 49.0 共重合体(b)/共重合体(e) 0.16/0.05 |
| 実施例 12 | 450 | 0 | 0 | 50 175 | 47.0 共重合体(b)/共重合体(e) 0.15/0.04 |
| 実施例 13 | 585 | 0 | 0 | 65 165 | 45.5 共重合体(b)/共重合体(e) 0.15/0.02 |
| 実施例 14 | 350 | 0 | 0 | 0 175 | 49.0 共重合体(b)/共重合体(e) 0.17/0.05 |
| 実施例 15 | 500 | 0 | 0 | 0 175 | 47.0 共重合体(b)/共重合体(e) 0.15/0.04 |
| 実施例 16 | 650 | 0 | 0 | 0 165 | 45.5 共重合体(b)/共重合体(e) 0.15/0.02 |
| 比較例 1 | 250 | 150 | 0 | 0 175 | 47.0 SP-N 0.60 |
| 比較例 2 | 350 | 150 | 0 | 0 175 | 47.0 SP-P 0.22 |
| 比較例 3 | 400 | 0 | 100 | 0 175 | 47.0 SP-N 0.70 |
| 比較例 4 | 400 | 0 | 100 | 0 175 | 47.0 SP-P 0.25 |
| 比較例 5 | 450 | 0 | 0 | 50 175 | 47.0 SP-N 0.65 |
| 比較例 6 | 450 | 0 | 0 | 50 175 | 47.0 SP-P 0.23 |

使用材料：

セメント(C)：普通ポルトランドセメント(3銘柄等量混合、比重3.16)
高炉スラグ粉(SL)：粉末度2,000cm²/g、比重2.90
フライアッシュ(FA)：粉末度2,800cm²/g、比重2.19
シリカフェューム(SF)：粉末度200,000cm²/g、比重2.20
細骨材(S)：大井川産(比重2.60、粗粒率2.76)
粗骨材(G)：青森産(比重2.64、粗粒率3.60)
水(W)：水道水
共重合体：表-2に示す一般式(I)及び一般式(II)の化合物と無水マレイン酸のモル比が50:50である共重合体を、特開平1-297411号公報に開示された方法に基づき製して使用した。
高性能AE減水剤：ナフタレンスルホン酸系高性能減水剤(市販品) SP-N
ポリカルボン酸系高性能減水剤(市販品) SP-P

表-2

| 共重合体の種類 | 一般式(I)および(II)の化合物 | 数平均分子量 |
|---------|---|--------|
| 共重合体(a) | $\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_{11}\text{CH}_3$ | 2.0万 |
| 共重合体(b) | $\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_{15}\text{CH}_3$ | 2.0万 |
| 共重合体(c) | $\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_{15}(\text{C}_2\text{H}_4\text{O})_{15}\text{C}_4\text{H}_9$ ¹⁾ | 3.5万 |
| 共重合体(d) | $\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_6(\text{C}_2\text{H}_4\text{O})_{12}\text{CH}_3$ ²⁾ | 3.0万 |
| 共重合体(e) | $\text{CH}_2=\text{CHCH}_2\text{O}(\text{C}_2\text{H}_4\text{O})_{11}\text{CH}_3$ | 4.5万 |

¹⁾ ランダム状付加物

²⁾ ブロック状付加物

表-3

| 区分 | 混練り直後 | | | 50分後 | | | 凝結時間 始発/終結 | 材料 分蘗 地産性 | | |
|--------|---------------|-----------------|--------------|---------------|-----------------|--------------|---------------|-----------------|------------|---|
| | Slump (cm) | Flow Air (%) | FS (cm/s) | Slump (cm) | Flow Air (%) | FS (cm/s) | | | | |
| 実施例 1 | 22.5 | 46.6 | 1.8 | 0.86 | 23.5 | 48.5 | 1.9 | 0.86 | 6:35/8:10 | ◎ |
| 実施例 2 | 23.5 | 50.5 | 1.2 | 0.65 | 22.5 | 52.2 | 1.1 | 0.68 | 6:40/8:30 | ◎ |
| 実施例 3 | 22.5 | 58.5 | 1.6 | 0.62 | 23.2 | 50.5 | 1.6 | 0.61 | 7:15/9:15 | ◎ |
| 実施例 4 | 23.0 | 59.5 | 1.2 | 0.65 | 24.0 | 51.2 | 1.3 | 0.61 | 6:50/8:45 | ◎ |
| 実施例 5 | 21.5 | 57.5 | 1.3 | 0.59 | 20.8 | 57.2 | 1.6 | 0.57 | 7:05/8:55 | ◎ |
| 実施例 6 | 22.5 | 59.5 | 1.7 | 0.63 | 23.8 | 61.5 | 1.5 | 0.61 | 6:50/8:50 | ◎ |
| 実施例 7 | 24.0 | 63.5 | 1.2 | 0.63 | 24.5 | 61.2 | 1.3 | 0.49 | 8:20/10:25 | ◎ |
| 実施例 8 | 21.9 | 59.5 | 1.4 | 0.53 | 22.7 | 61.2 | 1.3 | 0.51 | 6:45/8:55 | ◎ |
| 実施例 9 | 23.6 | 57.3 | 1.6 | 0.55 | 24.0 | 58.7 | 1.8 | 0.53 | 7:10/9:25 | ◎ |
| 実施例 10 | 23.0 | 62.6 | 0.9 | 0.51 | 24.5 | 61.8 | 0.7 | 0.53 | 7:25/9:35 | ◎ |
| 実施例 11 | 22.6 | 59.8 | 1.2 | 0.64 | 23.1 | 61.9 | 1.3 | 0.56 | 6:45/8:40 | ◎ |
| 実施例 12 | 21.4 | 57.5 | 1.0 | 0.65 | 22.8 | 60.3 | 1.3 | 0.51 | 7:00/9:05 | ◎ |
| 実施例 13 | 23.2 | 55.5 | 1.7 | 0.65 | 24.6 | 61.2 | 1.5 | 0.70 | 7:45/9:55 | ◎ |
| 実施例 14 | 21.0 | 39.5 | 1.9 | 0.80 | 21.5 | 42.5 | 1.7 | 0.85 | 6:50/8:45 | ○ |
| 実施例 15 | 22.2 | 44.0 | 1.5 | 0.77 | 24.5 | 48.5 | 1.3 | 0.80 | 7:05/9:00 | ◎ |
| 実施例 16 | 21.4 | 42.5 | 1.2 | 0.78 | 22.8 | 45.5 | 1.1 | 0.78 | 7:10/9:20 | ◎ |
| 比較例 1 | 23.0 | 52.6 | 0.8 | 0.38 | 13.5 | 36.5 | 1.0 | 0.41 | 7:55/9:50 | × |
| 比較例 2 | 23.3 | 53.1 | 1.8 | 0.56 | 20.2 | 48.8 | 1.9 | 0.49 | 7:10/9:20 | △ |
| 比較例 3 | 21.4 | 53.3 | 1.2 | 0.27 | 20.0 | 47.2 | 1.1 | 0.30 | 8:10/10:15 | × |
| 比較例 4 | 23.0 | 56.8 | 1.5 | 0.46 | 21.9 | 50.5 | 1.9 | 0.39 | 7:40/9:45 | △ |
| 比較例 5 | 23.8 | 58.5 | 1.2 | 0.52 | 21.4 | 53.8 | 1.3 | 0.45 | 8:15/10:30 | × |
| 比較例 6 | 24.1 | 57.2 | 1.5 | 0.65 | 21.1 | 53.9 | 1.6 | 0.61 | 7:55/10:00 | × |

ここで、FS(フロー速度)は[スランプフロー値 20]/2をスランプフローに要した時間で割った値を表わす。

[Translation done.]